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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

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NEWS

U. S. DEPARTMENT OF AGRICULTURE

FOR RELEASE: Tuesday, P.M.
July 20, 1971

NASA RELEASE NO: 71-129

PROJECT: CORN BLIGHT WATCH EXPERIMENT

PRESS KIT

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NEWS

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CORN BLIGHT WATCH EXPERIMENT

The United States Department of Agriculture, the National Aeronautics and Space Administration and corn experts in selected Corn Belt States are conducting a Corn Blight Watch experiment for cooperative ground and air study of possible Southern corn leaf blight during the 1971 growing season.

The observations are being conducted by NASA, USDA and seven Corn Belt States in cooperation with Purdue University's Laboratory for Applications of Remote Sensing, (LARS), LaFayette, Ind., and the University of Michigan's Institute for Science and Technology (IST), Ann Arbor.

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The program is designed to utilize remote aerial sensing techniques in coordination with special ground observations.

In 1970, Southern corn leaf blight -- combined with severe drought in some areas -- resulted in a decrease of about 15 per cent in the nation's corn crop. Last year NASA conducted a limited experimental program in conjunction with Purdue University and learned that corn blight could be detected from aircraft equipped with remote sensing instruments.

Major production losses occurred in the Midwest Corn Belt States. For that reason, the Corn Blight Watch experiment includes 1,806 fields in 210 selected sites located in the States of Ohio, Illinois, Indiana, Missouri, Iowa, Minnesota and Nebraska. Each site chosen is about a mile wide by eight miles long. The State of Michigan is participating independently through Michigan State University, East Lansing, by monitoring selected areas in the State.

Farms producing corn in each selected area have been surveyed in terms of previous cropping history, acreage planted to corn, varieties of seed corn planted, density of plant population, and general cultural practices being applied.

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Based upon this survey information, a group of sample fields has been selected for detailed study and observation. USDA personnel are carrying out plant-by-plant inspections of corn plants on these sites at about two-week intervals.

Simultaneously with ground studies, high-altitude aircraft flown for NASA by the U.S. Air Force Air Weather Service are repetitively photographing about 45,000 square miles of the corn belt area including 210 selected sites using special infrared and natural color film.

Major long-range goals of the project are to (1) monitor development and spread of corn blight during the growing season across the corn belt region; (2) evaluate the technique as a means of assessing the levels of infection in the corn belt; (3) evaluate the capability of remote sensing to assess the status and probable impact on crop production by corn blight and other foliar stresses; and (4) evaluate results for feasibility of application to similar situations occurring in the future.

Because of the experimental nature of the project, no formal statistical conclusions will be drawn or forecasts made concerning virulence, rate of spread, or ultimate effect on total corn production during the ground-air study June through September. Should the disease occur, however, information on where it has been detected will be made available only through Department of Agriculture's Corn Blight Information Center.

Although there is little the farmer can do to protect himself against corn blight at the present time, early warning may possibly give him time to protect his crop by spraying, or salvaging part of his crop by harvesting early, cutting for sileage or destroying blighted areas quickly to keep the disease from spreading as rapidly as it otherwise would.

The first phase flights during April obtained black and white photography of selected areas of the nation's Corn Belt region for use in orienting photo-interpreters and field personnel.

The second phase, obtaining color infrared photography, was completed during the month of May and was used by USDA to provide a background for an analysis of soil conditions prior to the emergence of this year's corn crop.

In the third phase, which began June 14 and continuing through September, the aircraft are obtaining high-altitude color infrared photography every two weeks in the Corn Belt test areas.

In this phase, the Corn Blight Watch experiment involves plant-by-plant inspections of portions of selected corn fields by Cooperative Extension Service (CES) and Agriculture Experiment Station (AES) personnel at about two-week intervals coordinated with NASA high-altitude photography of the sites using infrared and color film.

The high-altitude flights up to 60,000 feet by a U.S. Air Force RB-57F aircraft operating out of Scott Air Force Base, Ill., and Forbes Air Force Base, Kan., are under direction of the Earth Observations Aircraft Program Office of NASA's Manned Spacecraft Center (MSC), Houston.

In addition, the University of Michigan under contract to MSC is providing a C-47 aircraft carrying a multispectral scanner which is flying over an intensive study area in Indiana at about 5,000 feet.

The C-47 is flying 30 segments in the intensive test area to provide multispectral data for computer processing and analysis at LARS and IST.

All photographic data from both aircraft are forwarded to the Photo Reduction Center at LARS for analysis. The Center is staffed with 15 photo analysts from LARS, USDA and the participating states.

Results of biweekly field observations conducted by personnel from CES and AES are also fed to the Photo Data Center for correlation with photoimagery and subsequent analysis.

Multispectral data from the C-47 is machine processed at LARS and IST. These data are analyzed, using machine recognition programs, to identify corn fields and classify the presence and severity of blight.

All photo analysis and machine output are forwarded biweekly to USDA's Statistical Reporting Service (SRS) in Washington to identify infested areas and to feed data to a SRS statistical model which is used for evaluation purposes.

The intensive study area will permit exploration of improved sampling models and research with more advanced remote sensing technology and computer aided data reduction techniques.

Multispectral scanner data proved successful in initial corn blight detection flights conducted by NASA last fall. Combined with ground computer readouts the scanner was able to classify corn in five categories from healthy to severe infestation.

Successful identification can be important to agriculture in the future because it promises that remote sensing can give farmers warning of crop diseases approaching or even present in their fields before they are aware of it.

Another promising aspect is that large areas of farmland may be quickly and accurately surveyed from the air and probably, in the future, by satellite. The knowledge gained (type of crop in each field, size of the field, crop vigor, detection of any damaging agents and eventually yield-per-acre) may be used regionally and nationally on a timely basis by private and government interests to help keep the supply of essential food and fibers in balance with demand.

(END OF GENERAL RELEASE; BACKGROUND INFORMATION FOLLOWS)

BACKGROUND

The 1971 Corn Blight Watch experiment is based on a similar experiment carried out last fall on a test site extending from Michigan City, Ind., to the Evansville area in the southern part of the state.

During the final weeks of August and early September, 1970, NASA and Purdue University coordinated a corn blight sensing experiment in Indiana which involved a U.S. Air Force RB-57F flown at 60,000 feet for NASA, a C-47 flown at 3,000 feet by the University of Michigan under contract to NASA, a Purdue University Beechcraft flying between 5,000 and 10,000 feet and a U.S. Air Force C-131 flying at 17,000 feet.

Although cameras aboard the various aircraft, including infrared cameras, turned up significant results, the most precise data came from the multispectral scanner flown at 3,000 feet by the University of Michigan's C-47. The scanner receives distinct responses in 18 different segments of the infrared spectrum. This, combined with ground computers, resulted in digital information that was keyed to the severity of the infection.

Infrared photographs from high altitude cover vast areas rapidly with differences in color gradations quickly showing a skilled photo analyst the possibility of crop disease. Ground observations are necessary to confirm that a particular disease is present.

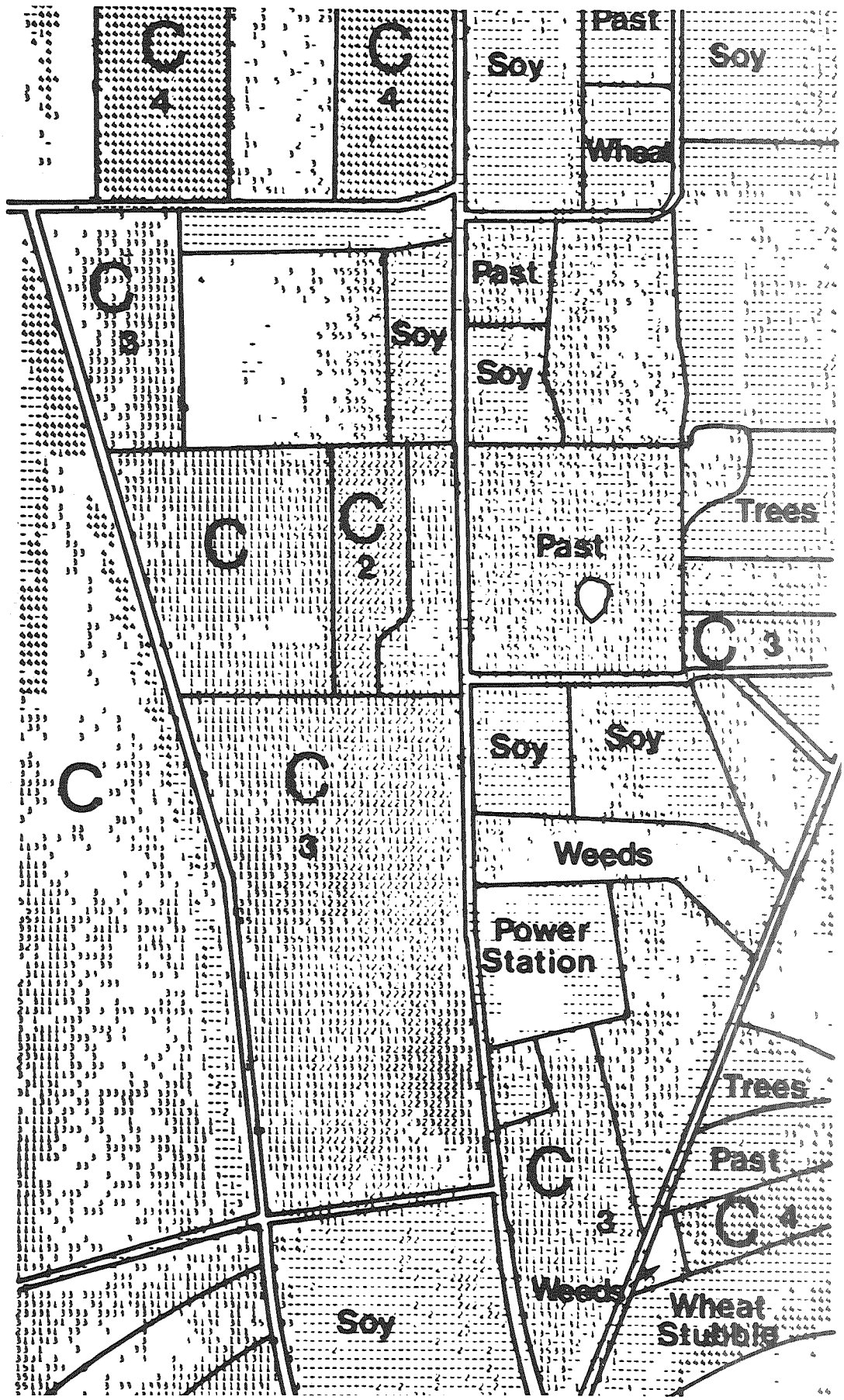
Combined with ground computer readouts the scanner was able to classify corn as (1) healthy; (2) very mild blight; (3) mild blight; (4) moderately severe blight; and (5) severe.

A computer printout clearly shows cornfields and the amount of infestation based on a digital system from 1 to 5 indicating healthy to severely infested corn blight. In addition, each field was classified according to number based on the numerical averages of each field. Some fields show very little to severe damage from the blight and this is reflected in the numbers printed out in the chart. Ground inspection confirmed the accuracy of the numerical printouts.

Where numbers show up in pastures or soybean fields it is an incorrect classification. However, by repetitive aircraft coverage the number of errors decrease rapidly to the vanishing point.

The cornfields show almost uniform numbers so that they are easily identified.

Analysis of the data was done by Purdue's Laboratory for Applications of Remote Sensing.


C 4
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C 2
C
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C 3
Weeds
Power Station
Trees
Past
C 4
C 3
Weeds
Wheat Stubble
Soy

OBJECTIVES OF THE CORN BLIGHT WATCH EXPERIMENT

The objectives of the 1971 Corn Blight Watch Experiment are as follows:

1. Monitor development and spread of corn blight during the growing season across the Corn Belt region.

2. Evaluate the technique as a means of assessing the levels of infection in the Corn Belt.

3. Evaluate remote sensing technology as it may amplify information useful in assessing the status and probable impact on crop production by corn blight or other foliar stresses noted during ground visits.

4. Evaluate results for feasibility of application to similar situations occurring in the future.

Sampling plan

A sampling plan for a seven state area within the Corn Belt has been designed for a complete remote sensing experiment. This part of the experiment is to develop a model for the application of remote sensing technology in assessing crop stress.

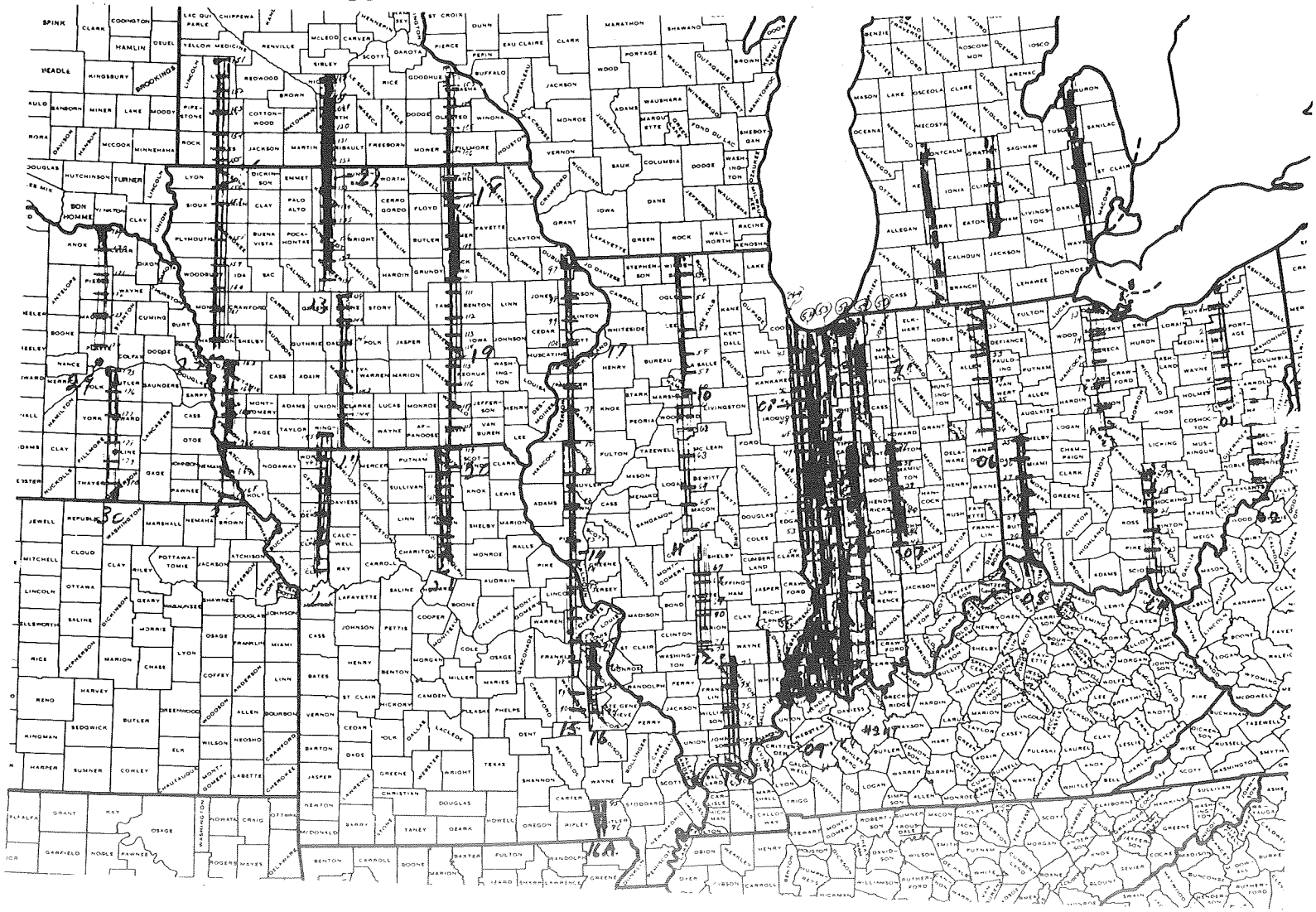
As an additional part of the experiment, an intensive study area has been selected within the seven state region to permit exploration of improved sampling models and research with more advanced remote sensing technology and procedures. In addition to high altitude photography in this area, multispectral data will be collected and computer-aided data reduction techniques will be used to evaluate these data.

These data will also be used to evaluate measurements acquired from the surface (ground) in conjunction with airborne photographic sensors and airborne multispectral sensors.

Test Area

A total of 210 sample sites will be monitored over a seven state area within the Corn Belt region. One-hundred and eighty of the sites are located in Ohio, Indiana, Illinois, Iowa, eastern Nebraska, southern Minnesota and northern and eastern Missouri.

"CORN BLIGHT WATCH"-1971-FLIGHT LINES AND OBSERVATION SITES



CORNBELT OBSERVATION SITES (180)
INTENSIVE AREA OBSERVATION SITES (30)
PROPOSED BY MICHIGAN (13)

1-30 &40-46 FK FLIGHT LINES SEGMENTS 1 THRU 180 AND 201 THRU 230
50-56 FLIGHT LINES APPLICABLE ONLY TO B&W BASE PHOTOGRAPHY

-more-

An additional 30 sites are in the intensive study area in western Indiana. Each sample site is approximately one mile wide and eight miles in length. Sites in the large test area are oriented east-west, perpendicular to the line of flight. The test sites are geographically positioned on 37 flightlines, each approximately 100 miles in length. The flightlines are oriented north-south. Sites in the intensive study area are oriented north and south.

It is considered desirable to include as much of the Corn Belt region as possible with the resources available to the project. The area selected includes about 60 per cent of the nation's corn acreage but 80 per cent of corn production.

Field Observations

Individual sites are accurately delineated on county maps. The photographic coverage required by the Agricultural Stabilization and Conservation Service (ASCS) for field enumeration of each observation site is then selected by reference to these county maps. Three sets of photography (photo-index sheets and 1:20,000 scale contact prints) are reproduced by the ASCS laboratories. The Statistical Reporting Service (SRS) will then transfer the delineations from the county maps to the ASCS photography which serves as the base photography furnished by NASA.

ASCS enumerators were trained by teams of representatives of SRS, ASCS and Purdue University Laboratory for the Applications of Remote Sensing (LARS) in May. ASCS enumerators then visited all farm operators in all observation sites before the end of May. Enumerators delineated and obtained the acreage for each field, identified all crops planted or to be planted, and obtained particular information for each corn field, including corn cytoplasm type (Normal (N), Texas Male Sterile (T), Blend (B)). These data were then returned to SRS where subsamples of corn fields were scheduled to be selected in each of the 210 observation sites between May 25 and June 10. Field visits to the sites are being made by Cooperative Extension Service (CES) and Agriculture Experiment Station (AES) personnel of the States of Ohio, Indiana, Illinois, Iowa, Missouri, Nebraska and Minnesota. Subsamples within observation sites were selected from each type of cytoplasm so that the different conditions in each site are represented.

Training of CES and AES personnel for those repetitive field visits was handled by teams comprised of representatives of SRS, LARS and designated plant pathologists.

The initial field visits to observe the corn crop were made during the week of June 14 and will continue on a biweekly basis through the week of September 20. If blight is suspected, leaf samples are forwarded to the diagnostic facilities in each state. Verification of blight is made by the state plant pathologist who advises all concerned parties of his findings.

Field observations and data collection at the test sites are accomplished by the CES and AES in each state. Field observation forms are mailed to a central location in each state. Data is forwarded via telephone or teletype to the Data Reduction Center at LARS if necessary to match imagery already received there. Computer calculations and listings from the field observation forms are prepared by SRS with copies provided to the Data Reduction Center.

Aircraft Data

Data acquisition flights for the three phases of the 1971 Corn Blight Watch Experiment began in mid-April and will continue through the month of September. All aircraft-acquired data is provided by an Air Force RB-57F flown for NASA's Manned Spacecraft Center (MSC) and the Institute for Science and Technology's (IST) C-47 which is under contract to MSC. NASA's Ames Research Center will provide backup capability for the RB-57F by providing the recently acquired U-2 aircraft when operationally ready.

In Phase One, during April 1971, the RB-57F overflew all test sites to provide photography over all test sites which were used as a tool for original field interviews and for orientation of analysts.

In Phase Two, an initial overflight of the survey area with color infrared photography (1:120,000 scale) was conducted early in May with the RB-57F. These data were used to provide soils background information on the various sample sites. IST's C-47 collected multispectral data over the 30 segments contained within the intensive study area during this phase to record the spectral characteristics of soils in the area.

During Phase Three, RB-57F overflights of the test area began in mid-June and are being made on a biweekly basis through September. At the same time, the intensive study area is being overflown by the IST C-47 also on a biweekly basis. The C-47 flights provide multispectral data of the intensive study area for processing at the LARS and IST facilities.

Photo Data Reduction

All original aircraft-acquired photography is processed by the NASA Manned Spacecraft Center. Two sets of duplicate positive transparencies are forwarded to the Photo Data Reduction Center at LARS within 48 hours following its delivery to the MSC processing facility. Two sets of contact IR color prints are forwarded to the center within six days of its delivery to MSC. The Photo Data Reduction Center is staffed by 15 photo-analysts provided by ASCS, ARS, the participating states and LARS. Members of the photo-analysis teams were trained by NASA, the Forestry Remote Sensing Laboratory, University of California (Berkeley); USDA; and LARS using materials developed during the latter part of the 1970 growing season.

The photo-analysis teams review the 210 test segments on the aerial photography with the aid of data supplied from field observations. Analysis results are being sent to SRS for inclusion in their statistical models.

As the photo data reduction teams are analyzing the photography, hard copy contact scale color infrared prints, made available by NASA/MSC, are sent to the 200 counties participating in the seven state experiment. These 1:120,000 scale prints permit county ASCS and Extension Service personnel to become familiar with repetitive small-scale photography. This facet of the operation establishes a nucleus of personnel for future exploitation of data from the Earth Resources Technology Satellites (ERTS) scheduled for launch next spring, and future programs.

Spectral Data Reduction

Multispectral data collected by the IST C-47 over the intensive study area is reduced at IST and LARS. For each mission LARS processes the multispectral data over 15 selected sites and IST processes the multispectral data acquired over the remaining 15 sites. In these investigations, each of the sites within the intensive study area is analyzed using machine recognition programs to identify corn fields and to classify them as to presence and severity of blight.

Data Utilization

Photo-analysis output, machine-processed multispectral scanner output and field observation data are forwarded to SRS in Washington biweekly to identify infected areas and to feed data to the statistical model for prediction.

SOUTHERN CORN LEAF BLIGHT

Southern corn leaf blight is a disease caused by the fungus Helminthosporium maydis. It affects field corn, sweet corn, and popcorn. Until 1970, the disease occurred primarily in the Southern States, and was considered of minor importance.

In 1970, a new race of the disease known as race "T" appeared. This new strain attacks the ears, leaf sheaths, and shanks of the plant, as well as the leaves. It is most virulent on hybrids containing a male sterile cytoplasm (a characteristic that eliminates the need for hand-detasseling in seed production).

The disease can be spread in a variety of ways. Spores can be blown by winds from infected areas. The fungus can survive for several years on dry tissue. Thus, it's possible for the fungus to overwinter by way of kernels, ears, or plant residues.

Symptoms of the disease vary depending upon the type of corn hybrid grown, presence of other corn diseases, amount and distribution of rainfall and dew, temperature levels, stage of plant development and other factors.

The fungus is most likely to develop and spread during wet, humid weather when temperatures range from 65 to 80 degrees.

Symptoms of leaf infection appear as irregularly shaped spots, more or less elongated with the veins of the leaf. They vary in size from about one-fourth to three-fourths of an inch in length and one-fourth to one-half inch in width. Lesions unite, resulting in larger spots. Lesions are usually tan and may have a reddish-brown border. The dark border often shows up after the leaf has been killed.

Leaf sheath infection appears as purplish black spots which eventually develop tan or grayish tan centers. They vary in size from one-fourth to one inch in diameter, and up to four inches in length. Infection similar to that on the sheath may appear on adjoining stalk areas.

Lesions may appear at any point on the ear. The fungus may attack all parts of the ear including shank, husk, kernels, and cob.

Husk infection appears as roughly circular, well-defined lesions, grayish in appearance, but becoming blackish. Lesions may be one to three inches in diameter. When the husk is peeled back, lesions will be found to penetrate through the inner layers.

The fungus spreads rapidly into and between the kernels and into the cob. Kernels may have a faint grayish-black appearance, or may appear to be charred. Infection often takes place at the tip of the ear, and is capable of invading the seed.

Extent and Effect of the Disease -- 1970

The 1970 outbreak of race "T" of southern corn leaf blight apparently first occurred in the United States in the area of Belle Glade, FL.

The disease reached epidemic proportions in that area during late February and March. The disease continued to spread during the spring months, eventually moving during the summer months into nearly all of the major corn producing areas of the Eastern half of the Nation.

Extent of the reduction in yields to corn producers nationally in 1970 as a result of corn leaf blight is difficult to estimate. However, corn leaf blight, combined with severe drought conditions in some areas, is estimated to have reduced 1970 corn production about 700 million bushels -- from an estimated total of 4.8 billion bushels on July 1, 1970, to about 4.1 billion bushels by the time harvest was completed.

In 1970, the disease caused wide differences in corn production by areas. In Pennsylvania, Maryland and Virginia, the crop was 20 percent above normal but these States produce only 4 or 5 percent of the U.S. total. Output was 14 percent above normal in the Lake States, which produce about 15 percent of the total crop.

In the Western Corn Belt, where nearly 40 percent of the crop is produced, output was a little below average due largely to dry weather along with some blight damage.

In Ohio, Indiana, and Illinois blight damage cut the crop by about 15 percent below normal yields. These States produce about one-third of the U.S. total.

The Southern States were hit hard by the blight. The four leading corn producing States of the South--North Carolina, Tennessee, Kentucky, and Georgia--had only 70 percent of their normal crop. However, these States account for only 5 percent of the U.S. total.

Outlook for 1971 -- Seed Supplies

No one can predict with any certainty what the extent and severity of southern corn leaf blight will be in 1971. Major factors likely to affect the crop include weather conditions, ability of the disease to overwinter, and supplies of disease-resistant seed. Of these factors, seed is the only one over which producers have any control.

Three types of hybrid seed have been in use for many years. These have been designated "N," "T," and "B".

The N type hybrids have normal cytoplasm and are produced by detasseling. T type hybrids are produced with a female parent which carries the T type of sterile cytoplasm. These hybrids are male sterile unless the male parent carries the ability to restore pollen fertility. The B type is a blend or mixture of N and T components of a given hybrid. Thus part of the plants are male sterile and part male fertile, ensuring adequate pollen under field conditions.

These hybrids differ in degree of resistance to race T of southern corn leaf blight. The N type hybrid is most resistant to the disease, while the T type is most susceptible. Blends of the N and T types possess some degree of resistance.

For the 1971 crop year, companies normally handling about 80 percent of the Nation's seed corn production indicate about 829 million pounds of seed will be available for planting. Of this total, about 23 percent will be N type seed, 40 percent T type seed, and 37 percent B or blend-type seed. The 1970-71 winter production made up about 2.7 percent or 22 million pounds of the total supply.

DEPARTMENT OF AGRICULTURE CORN BLIGHT ACTIVITIES

The Corn Blight Watch experiment is one of several activities involving USDA in 1971 to assure prompt gathering and evaluation of research and other information and accurate reports on the status of the disease in 1971. Other activities are:

° USDA Interagency Task Force on Corn Blight

The USDA Interagency Task Force on Corn Blight was developed in the Fall of 1970 in response to USDA recognition of the need for some mechanism to evaluate the corn blight problem and provide policy guidance to the Department.

The task force consists of representatives from the Agricultural Research Service, Statistical Reporting Service, Economic Research Service, Agricultural Stabilization and Conservation Service, Extension Service, and the Cooperative State Research Service. The task force reports to Dr. Ned D. Bayley, Director of Science and Education; therefore, this group in its responsibilities transcends agency lines. This group, relying largely on resources of an Extension Service Task Force on Corn Blight, has prepared two Departmental publications. In addition, the Task Force worked with SRS and the American Seed Trade Association in obtaining inventories of hybrid seed corn supplies for 1971.

° National Federal-State Information Center on Corn Blight for 1971

The major responsibility of the Information Center is to assemble, evaluate, and distribute summarized information concerning all aspects of the corn blight situation during the 1971 crop season should the disease develop. The Center will depend on a cooperative relationship, involving information exchange, with USDA agencies, State Research, Extension, regulatory and other groups, and various commercial and private organizations. It will not serve in a farmer advisory or other policy-oriented capacity.

Weekly (or as needed) press releases will be cleared through the Statistical Reporting Service, Interagency Task Force on Corn Blight, and other appropriate USDA agencies. In addition, periodic reports will be made available to research groups, State Extension Service personnel, representatives of other Federal agencies, and to all other interested groups requesting the information.

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° Dixie Early Warning Line (DEW Line)

The Dixie Early Warning Line is a communications network developed by Extension Plant Pathologists in Southern corn producing States to facilitate the regular exchange of corn blight information throughout the growing season.

The network which includes a telephone conference capability among all Southern Extension Plant Pathologists and certain Extension Plant Pathologists in Corn Belt States, will include regular weekly communication to provide a joint assessment of the corn blight situation in the event the disease should occur during the growing season. Cooperating Plant Pathologists will also prepare reports on the condition of selected corn fields during their continuing surveys for exchange within the network and for mailing to other key persons.

° Southern Corn Leaf Blight Reporting Service

The Southern Corn Leaf Blight Reporting Service is a Federal-States cooperative project involving plant pathologists of the Agricultural Research Service, USDA, and the State Agricultural Experiment Stations in virtually all of the Corn Belt States and most of the Southern and Northeastern States where corn is produced.

Cooperating State Plant Pathologists have agreed to set up spore collection traps at strategic locations in their respective States, and report information on collection of the corn blight fungus, Helminthosporium maydis, Race T, to the project coordinator.

This experimental effort is designed to develope information which will be used to test the feasibility of this type of disease monitoring system in forecasting Southern Corn Leaf Blight.

The data will be used to develop an analytical model which will be used to test the system. Climatological information will also be made available by the Agricultural Climatology group in the Department of Commerce for this cooperative project.

° Uniform Regional Corn Planting Program

Cooperative USDA-Regional Corn Conference uniform variety planting programs have been in progress for many years. In response to the corn blight epidemic of 1970, representatives of the Cereal Crops Research Branch, ARS-USDA, and the Corn Improvement Conferences of the Northeast, North-central, and Southern Regions have developed coordinated plans to plant nurseries of inbred and hybrid dent corn in selected sites in these regions.

In addition to the uniform plantings, State cooperators will also make limited plantings of their own selections for evaluation of resistance to Southern Corn Leaf Blight and other diseases. These plantings will also serve as indicators of first blight infections in a given area by using appropriate "trap" plants.

Data obtained from these regional plantings will therefore complement the Corn Blight Reporting System, the DEW Line, and should be of value to the Corn Blight Watch Experiment.

CORN BLIGHT WATCH EXPERIMENT PARTICIPANTS

USDA

Participating USDA agencies and activities:

- °Statistical Reporting Service (SRS)
  - . Statistical sampling design
  - . Preparation of survey materials
  - . Training enumerators
  - . Data analysis
  - . Evaluation of extent of infection and periodic release of information to the public
- °Agricultural Stabilization and Conservation Service (ASCS)
  - . Ground data acquisition
  - . Photo analysts
  - . Training enumerators
  - . Photography support
  - . Photo-interpretation equipment
- °Extension Service (ES)
  - . Coordination of CES activities
- °Cooperative State Research Service (CSRS)
  - . Program coordination
- °Economic Research Service (ERS)
  - . Economic evaluation of experiment
- °Agricultural Research Service (ARS)
  - . Photo Analyst

NASA

Participating NASA activities:

- °Earth Resources Aircraft Project (ERAP)
  Manned Spacecraft Center (MSC), Houston, Texas
  - . RB-57F aircraft
  - . Data processing facilities

  Earth Resources Aircraft Project, Ames Research Center (ARC), Mountain View, California
  - . U-2 backup aircraft
- °Purdue University
  Laboratory for Applications of Remote Sensing (LARS)
  Lafayette, Indiana
  - . Multispectral data analysis personnel and facilities
  - . Photo-analysis training facility
- °University of Michigan
  Institute for Science and Technology (IST)
  Ann Arbor, Michigan
  - . C-47 aircraft
  - . Data reduction facilities

PURDUE UNIVERSITY
- °Program Coordination
  - · Overall program coordination
  - · Coordination of the Agricultural Experiment
  - · Station Directors
  - · Coordination of the Cooperative Extension
  - · Service Directors
  - · Representation of the State Corn Blight Watch Coordinators
- °Development and supervision of photo-analysis center

UNIVERSITY OF CALIFORNIA
- Forestry Remote Sensing Laboratory
  - °Instruction of photo-analysts in the fundamentals of photo-interpretation

COOPERATIVE EXTENSION SERVICES AND AGRICULTURAL EXPERIMENT STATIONS OF THE STATES OF OHIO, INDIANA, ILLINOIS, IOWA, MINNESOTA
- °Collection of ground data within sample sites
- °Training enumerators
- °Laboratory identification and confirmation of disease and other conditions
- °Photo-analysts

UNIVERSITY OF MICHIGAN AND MICHIGAN STATE UNIVERSITY
- °Conducting independent research program on corn blight incidence in Michigan. They will be making the same kind of ground measurements, using the same forms as for the Corn Blight Watch Experiment. The study results will be made available to SRS.

UNIVERSITY OF MICHIGAN

The University of Michigan's participation in the experiment is:

1. Assist in planning the experiment.

2. Conduct eight data collection missions over the intensive study area of western Indiana at two week intervals during the corn growing season. Approximately 300 square miles of multispectral data will be collected on each mission.

3. Process and analyze half of the multispectral data collected to note the spread of corn blight in the intensive study area in near real time. Purdue will process and analyze the other half of the multispectral data. The processing task includes the acquisition of training set data through ground observation of corn condition at selected sites.

4. Furnish a photo interpreter to work at Purdue under their direction to help in the analysis of high altitude infrared color photography to determine the extent of the corn blight in the intensive study area of western Indiana. The photography will be obtained by the RB57. This interpreter will also help in supplementing ground observations of corn conditions to help in selecting suitable training sets for automatic processing.

5. Assist in determining the success of the experiment in showing the extent of the corn blight in a timely manner by various remote sensing techniques.

The multispectral data collection and processing capabilities were developed by The University of Michigan under government sponsorship as a part of the University's Willow Run Laboratories.

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Data Collection

The multispectral data collection system is composed of an optomechanical line scanner with three detector assemblies which provide calibrated radiation imagery and references through 12 multiband data channels in the 0.3 to 14.0 micrometer wavelength region. The system is an airborne imaging sensor which registers the spectral properties of a terrain scene in absolute measure in the form of an electrical signal. The electrical outputs are amplified for recording on tape.

The airborne sensor equipment is installed aboard a C-47 aircraft operated by the Willow Run Laboratories. Two instrumentation wells in the bottom of the aircraft house the imaging equipment. Aerial cameras mounted in one of the wells photograph the same scene the scanners map, thus aiding data interpretation. The airborne system is operated by a crew of six, including the pilot, copilot, and flight engineer. Although system performance in the visible region is limited to daylight hours with good weather conditions, the infrared bands can be sensed day or night. Data is collected at flight altitudes from 500 feet above terrain to 15,000 feet above sea level.

The unobscured field of view of the scanner is 90° across the flight line. The scanner imagery is stabilized to remove aircraft roll motion, but no corrections are made for aircraft pitch and yaw during the scan.

Spectral signatures of targets as small as approximately 10 feet in diameter at 1,000 feet altitude can be registered quantitatively in 12 bands on magnetic tape. The quantitative measure of the signal level (radiance) in each band is established by interpolation between two known radiation inputs at the scanner aperture. The radiation inputs are common to all data channels within the scanner.

Data Processing and Display

The data obtained in the multiple spectral regions are processed to facilitate discrimination, either by an interpreter from displays or by an automatic device whose outputs are displayed.

Data obtained from multichannel devices can be processed in ways that will give increased flexibility to interpreters, e.g., appropriate weightings and combinations of the signals, and the use of a color display or color film recording process, to provide even greater contrasts than are presently achievable. For example, data in pairs of channels can be subtracted as well as added before being displayed and a greater number of regions can be used; one could also differentiate or quantize the signals before displaying them in order to enhance boundaries. Where the resulting contrasts and tones or colors are unique and repeatable, simple automatic recognition devices can be implemented; where they are not, other more complex recognition schemes can be tried.

Most recognition schemes that use multispectral data implement some form of spectrum matching. For the two channel case, one could simply require that the signals be in specified intervals simultaneously on each of the channels. A recognition signal would be produced only when this criterion had been met. Clearly, such a scheme could be extended to many more channels. One could also require that the incoming multi-channel signal be a specified distance from a reference signature before a recognition were made. There are a variety of distance measures that can be used. Among them are (1) the sum of the absolute differences between the incoming signal vector and a reference signature, and (2) the sum of the squares of the differences between input and reference (i.e., a hyper-spherical decision boundary). Also, the variances of the signatures could be reduced by compensating for angle-dependent effects.

The outputs of the processors and recognition devices may take many forms. When the human functions in the system, processed outputs which preserve the spatial content of the scene are desirable. Recognition printouts or plots can be produced in which the resolution elements are represented by shades of gray colors, or printed symbols, according to the decisions made. Auxiliary computations and calculations can also readily be made for the user.

The computations involved in implementing the various processors can be performed by analog or digital equipment or by hybrid combinations. Each of these has its advantages and disadvantages. Both analog and digital techniques are being used at The University of Michigan's Willow Run Laboratories.

PURDUE UNIVERSITY

Purdue University is involved in the Corn Blight Watch Experiment in a dual capacity. The University itself is involved through its Extension Service and Experiment Station in a role similar to that of the six other cooperating states in the Corn Blight Watch; that is, Cooperative Extension Service personnel will be gathering ground data every two weeks through the growing season; Experiment Station personnel will be analyzing leaf specimens sent by Extension agents to verify any presence of southern corn leaf blight.

In addition to the function provided by Purdue which is similar to that in each state, the director of the Cooperative Extension Service, Howard Diesslin and the director of the Experiment Station, Herbert Kramer have been selected by the other cooperating directors to coordinate these activities in the participating states. In turn, Dr. J. B. Peterson of LARS has been selected as the representative of Directors Kramer and Diessline to coordinate the ground data collection and related activities of these states as well as Indiana.

The second capacity in which Purdue University is involved in the Corn Blight Watch Experiment is through the Laboratory for Applications of Remote Sensing which will be involved in several functions. This laboratory is providing the physical location of the Data Reduction Center and is to be instrumental in its set-up and operation. Personnel and equipment for photographic analysis are being furnished by ASCS, ARS, several states involved, and others. Equipment includes rear projection viewers, stereoscopic viewers and light tables. LARS is furnishing personnel to establish and coordinate these facilities and their related activities. The summarization, storage, and retrieval of data from photo analysis and scanner analysis will be done by LARS and Data Reduction Center personnel in close cooperation with SRS participants.

LARS will also be instrumental in conducting remote sensing research in collaboration with IST at University of Michigan. Scanner data from 30 segments within the Intensive Study Area in western Indiana will be processed utilizing computer aided techniques developed over the past years at these locations. Results of this analysis will be compared with results of photo-interpretation and ground data observations to determine the relative merits of such data sources and best combinations.

A third capacity in which LARS will be involved is in planning and coordination of three different activities. The first is ground data collection by county ASCS and Extension Service personnel. The second is in photo analysis at the Data Reduction Center in cooperation with the University of California, Berkeley. The third is planning and coordination of the aircraft data acquisition missions with NASA/Houston personnel and IST personnel.

A fourth capacity in which LARS will be involved is in training. LARS personnel have been involved in the training of ground data acquisition teams of ASCS and Extension personnel. This has been in cooperation with SRS, ASCS, and state and regional supervisors. LARS is also involved in training of photo-analysts at the Data Reduction Center. This training is being accomplished in coordination with the University of California.

Several LARS personnel are members of an ad hoc working group known as the Corn Blight Watch Executive Committee. This group is performing a number of planning, coordinating, and other functions.

STATE OF ILLINOIS

Forty-seven county advisers for the University of Illinois Cooperative Extension Service were trained in early June at the U. of I. College of Agriculture at Urbana-Champaign to participate in the Corn Blight Watch experiment.

From 36 Illinois counties, the Illinois advisers join more than 200 other Extension advisers in eight states to take part in the effort to detect and monitor the spread and extent of corn blight this summer.

The Extension advisers will conduct the "ground truth" phase of an aerial, infra-red photography study by Purdue University's LARS.

Aerial photos of 210 eight-square mile segments will be taken in the Corn Belt area by a USAF RB-57F aircraft flying at 60,000 feet. The RB-57F flight will be biweekly on Monday. On Tuesday following the flight, Extension advisers will conduct biweekly "ground truth" operations.

Four "ground truth" advisers will visit a sample of corn fields within each segment and inspect for blight. The advisers will report corn plants with blight lesions, stalk rot, or other disease condition within each segment. Growth conditions such as tasseling, and ear formation will also be reported.

Adviser reports will be forwarded to a LARS team at Purdue University where special photo interpretation teams will prepare reports. Copies of the biweekly LARS report will go to each state and to each county in the study area.

The blight watch project started June 14 and the biweekly photo flights and ground watch visits will continue through the week of Sept. 20. E. E. Golden, assistant director of the U. of I. Cooperative Extension Service, will coordinate the Illinois Extension advisers' activity.

STATE OF INDIANA

Personnel of both the Agricultural Experiment Station and the Cooperative Extension Service of Purdue University will be active in the Southern Corn Blight Watch Experiment. The Experiment Station is providing the services of a plant pathologist and laboratory facilities to identify and verify samples of corn suspected of infection by the particular blight, helping with training schools for field enumerators and consulting as needed on technical problems relating to the blight.

The Cooperative Extension Service will supply people to make field studies of the segments selected from the flightlines for experimental studies of the possible occurrence of blight in corn fields. This essential part of the large scale experiment is necessary to relating "ground truth", that is the actual conditions at the ground level to what is being recorded by remote sensing techniques.

These field observers, called "enumerators", in the experimental plan will have two important missions in Indiana: (1) to make proper biweekly reports on needed ground truth for 12 one by eight mile segments in more regular flightlines of the overall experiment which fall in Indiana and (2) to do the same for 30 segments in a more intensive phase of the experiment concentrated in western Indiana. This intensive study area is unique in that not only will color infrared photography be obtained from the high-altitude aircraft, but in addition, multispectral scanner data will be collected and analyzed by computer techniques.

Each state land grant university cooperating in the experiment has designated a university staff member to coordinate all the state activities relating to the experiment. To coordinate the total effort of the seven states aiding in the experiment, namely Nebraska, Iowa, Minnesota, Missouri, Illinois, Ohio and Indiana, the state coordinator for Indiana will act as overall coordinator of the activities of the seven cooperating states. He will also be representing the Agricultural Experiment Station director and Cooperative Extension Service director of Purdue University who are the elected representatives of the directors of the Experiment Stations and Cooperative Extension Service director of Purdue University who are the elected representatives of the directors of the Experiment Stations and Cooperative Extension Services of the seven states.

STATE OF IOWA

In Iowa, each site will be approximately one mile wide and eight miles long. Forty sites are located in Iowa. Eight fields will be checked in each site.

NASA will fly the corn belt every two weeks taking infrared pictures. At the same time that these pictures are being taken, Iowa State University Extension Personnel will be checking the same fields for southern corn leaf blight. These fields will be checked every two weeks between June 15 and September 20.

Since this is an experiment, the infrared pictures will not be available in time to make any suggestions to farmers. However, the ground data compiled by extension personnel will be available to the Iowa State University Blight Committee, which will use this information in conjunction with other observations and other experiments to make suggestions to farmers. These suggestions, for example, could include when and where it might be economically feasible to spray for blight control.

State and local agencies involved in the experiment are state and county ASCS, the Cooperative Extension Service and Iowa State University. Others include NASA, various branches of USDA, the Laboratory for Applications of Remote Sensing at Purdue University and the Institute of Science and Technology at the University of Michigan.

Dr. H. E. Thompson, Cooperative Extension Service Agronomist, is Coordinator for Iowa.

STATE OF MINNESOTA

The contribution of Minnesota corn producers to national production is significant, amounting to about 5 million acres. Corn blight last year attacked corn grown in the Southeastern third of the state, but the overall losses appeared to be rather minor. There is therefore a keen interest in the role that improved disease detection and monitoring efforts might have on Minnesota crop production.

Dr. Herbert G. Johnson, Extension Plant Pathologist at the University of Minnesota, is the State Coordinator for Minnesota's contributions to the Corn Blight Watch Experiment. He is working with USDA's ASCS State Executive Director, Samuel M. Peterson, in coordinating this complex program. The field observation efforts involve about 15 state experts and two ASCS County Executive Directors. Department heads in various subject matter areas at the Minnesota Agricultural Experiment Station, have interests in many facets of this experiment.

Approximately 135 fields in 15 statistically selected sites are under observation during this experiment.

STATE OF MISSOURI

Staff members from the University of Missouri-Columbia and the University Extension Division will provide ground support as Missouri is part of the corn blight watch experiment.

Oscar Calvert, associate professor of plant pathology at UMC, is the state coordinator and key pathologist for Missouri in this undertaking.

In cooperation with Purdue LARS, NASA planes will fly over designated areas of Missouri, photographing carefully chosen fields. The planes will cover most of the corn-growing portions of the state.

The pilots will be using infra-red and other special film that responds to radiated temperature differences on the ground. Just like a child that is ill, corn and other crops that are suffering from disease "run a temperature." The infra-red film will identify those fields which have normal temperatures and those which don't.

It will be the job of the ground support teams to record the condition of the photographed fields at the time of the aerial photography and send in reports so that NASA-LARS photo interpreters can learn more about what their films are telling them.

Ground observations will be made on June 14, June 28, July 5, July 19, August 2, August 16, and August 30, and September 15. The ground observers received special training in sessions held in Columbia at the University on June 7 and 8.

As key pathologist, Calvert works closely with Einar Palm, State Extension Plant Pathology specialist who is Chairman of the UMC Corn Blight Committee. Eleven area agronomy specialists supervised by state extension agronomy specialist Bill Murphy will make field observations or select alternates to do them.

There will be from six to 10 corn fields to observe in each segment of the test area on each date. It is anticipated that it will take each man a full day to make his observations on each of those dates.

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The Missouri support program will differ from some other states. Ten to 12 observers will cover the 26 segments of Missouri observations needed by LARS-NASA. Other states have allotted as many as 39.

The ground observer group is being selected from area agronomy specialist, vocational agriculture teachers, retired extension personnel, graduate students of the College of Agriculture, and others with appropriate backgrounds.

STATE OF NEBRASKA

NASA aircraft (RB-57F) flying at 60,000 feet will photograph specified areas in Nebraska on a bi-weekly schedule. High altitude color infrared photographic data acquired from the eight flight missions (14 June to 20 September) will be intrepreted by photo-analysts with the aid of data obtained by ground observers. Ground observations are to be made on the day of the overflights, if possible, also at bi-weekly intervals. Ground data (or field visit data) will be the responsibility of each state's Cooperative Extension Service, while the photo-analyst is sponsored by their respective State Agricultural Experiment Station.

In May, interviewers from each county's ASCS office talked to farm operators about each selected corn field. The information obtained was given to the ground observers before the first field inspection visit. The Statistical Reporting Service (SRS/USDA) is responsible for the statistical design of the experiment.

The experiment includes a total of 30 flightlines, running north and south, located in the seven state area. Nebraska has two complete flightlines with a portion of a third in Richardson County. Each flightline is eight miles wide and 100 miles long. Six one-by-eight mile segments have been located approximately 16 miles apart within each flightline. These segments run east and west at right angles to the long axis of the flightline. Each 1 x 8 mile segment will include eight sites (corn fields), and there will be two "units" within each field. A unit consists of two rows of corn 15 feet long.

David S. Wysong, Extension Plant Pathologist at the University of Nebraska, is Chairman of the Corn Blight Watch Committee.

STATE OF OHIO

State farmers currently planted about three million acres of corn, amounting to a meaningful contribution to U.S. corn production. State and county experts are actively engaged in the various phases of the Corn Blight Watch Experiment.

The State Coordinator, Dr. Austin B. Ezzell of the Soil Cooperative Extension Service, works closely with plant pathologist, Dr. Lansing E. Williams. In addition, Dr. Ezzell coordinates State activities with ASCS State Executive Director, Dwight R. Harris and Compliance Specialist, Ralph H. Cochrane.

About 30 extension agents are making ground observations of 330 corn fields in 30 statistically selected sites in the State. Three ASCS County Executive Directors are also providing coordinating effort to the experiment.

U. S. AIR FORCE RB-57F DESCRIPTION

The RB-57F is a mid-wing, four-engine Air Force aircraft capable of operating at altitudes above 60,000 feet. It has a range of 2,800 miles and a speed of 400 knots. The airplane fuselage is constructed in three sections, with the forward section containing separate tandem stations for the two crew members. The pilot's station contains all the equipment and controls necessary for flying the airplane. The navigator's station has been converted to a special equipment operator station containing both standard navigation equipment and NASA remote sensor equipment controls and indicators. The center fuselage contains the battery compartment, hydraulic equipment, and electrical equipment. An instrument pallet provided by the NASA Manned Spacecraft Center is attached to the underside of the center fuselage compartment. Electronic equipment and miscellaneous ground handling gear are located in the aft fuselage.

Aircraft Operations

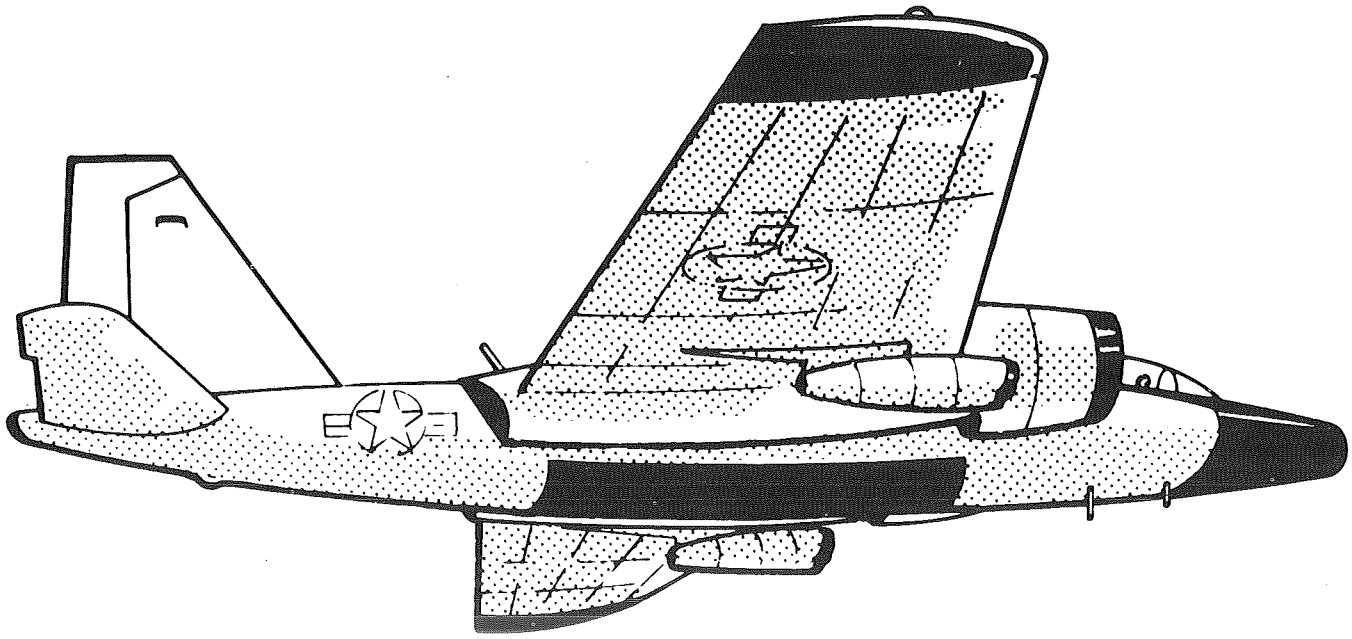
The RB-57F is flown and maintained for the NASA Earth Observations Aircraft Program by the U. S. Air Force Air Weather Service, 58th Weather Reconnaissance Squadron, Kirtland AFB, NM. The aircraft operates primarily from Kirtland and from Ellington AFB near Houston. Mission sites beyond practical range of the aircraft are over-flown from staging bases at McClellan AFB, Sacramento, CA; Wurtsmith AFB, Oscoda, MI; Patrick AFB, Cocoa Beach, FL; Atlantic City NAFEC, Atlantic City, NJ; Griffis AFB, Utica, NY; McCoy AFB, Orlando, FL; Scott AFB, Belleville, IL; and Forbes AFB, Topeka, KA. Other bases may be selected if required.

The RB-57F is powered by two TF33 turbofan engines and two J60 turbojet engines. Each TF33 engine provides up to 16,000 pounds thrust. The two TF33 engines also provide pressurization, hydraulic and electrical power. The J60 engines, designed for operation at higher altitudes, are started after takeoff to provide additional thrust for high altitude climb and cruise.

Oxygen for the two-man Air Force crew is stored as a liquid and is converted to a gas for breathing. At altitudes above 45,000 feet the crewmen wear pressure suits for protection against emergency cabin depressurization or bailout. The suit consists of a four-layer pressure garment and a helmet constructed of a hard outer layer and a padded inner layer.

NASA-S-68-3841

RB - 57F



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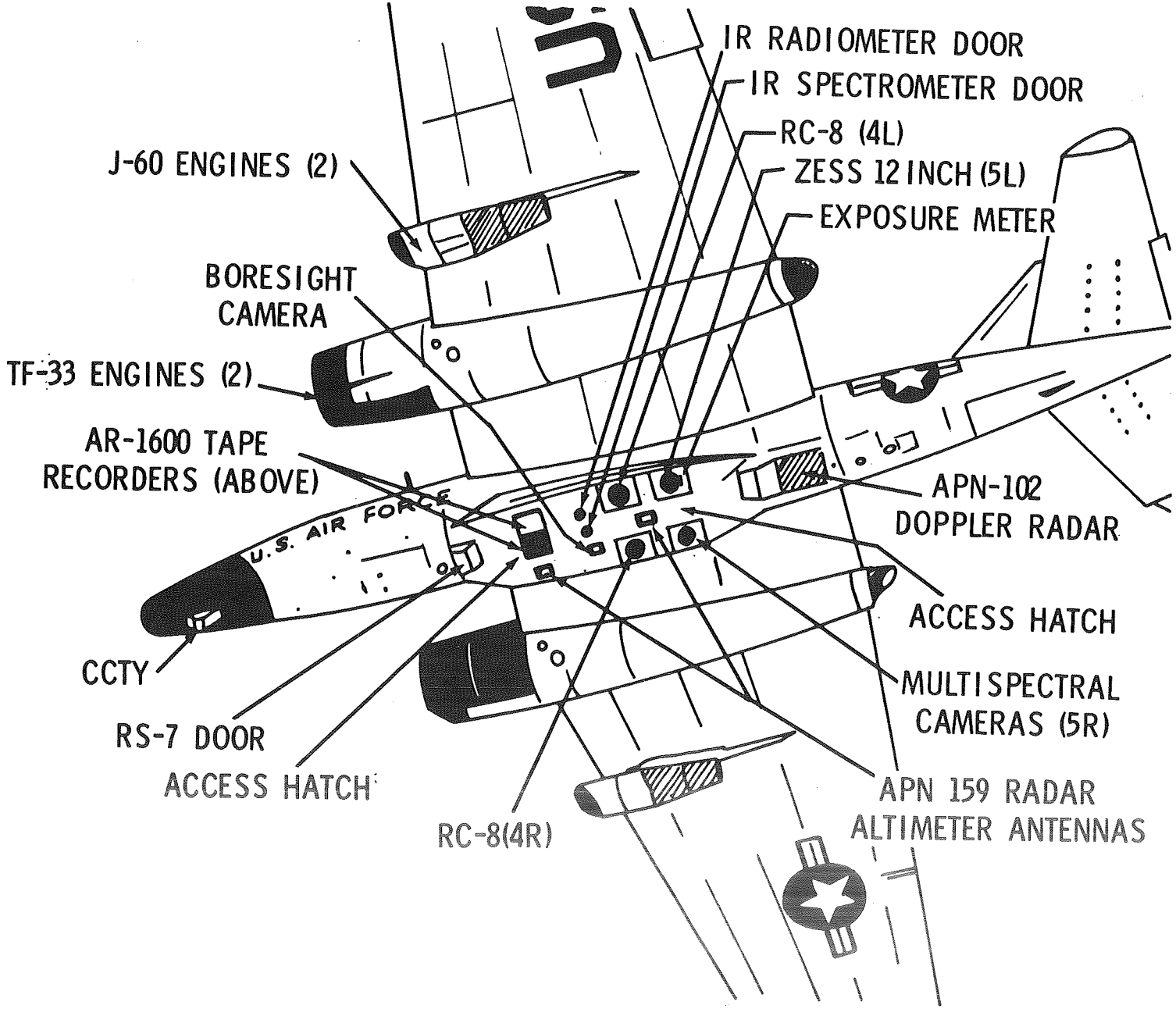
RB57F 13501 NASA PALLET



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The RB-57F navigation system includes a gyrosyn compass, a doppler radar, and a navigation computer. The system measures the heading, groundspeed, and drift angle of the aircraft. With these measurements, it is possible to compute present latitude and longitude, distance to destination, groundtrack and relative bearing.

A closed circuit television camera is mounted in the nose radom of the aircraft and allows the special equipment operator to view the terrain beneath and forward of the aircraft and to measure drift.

Instrument Pallet

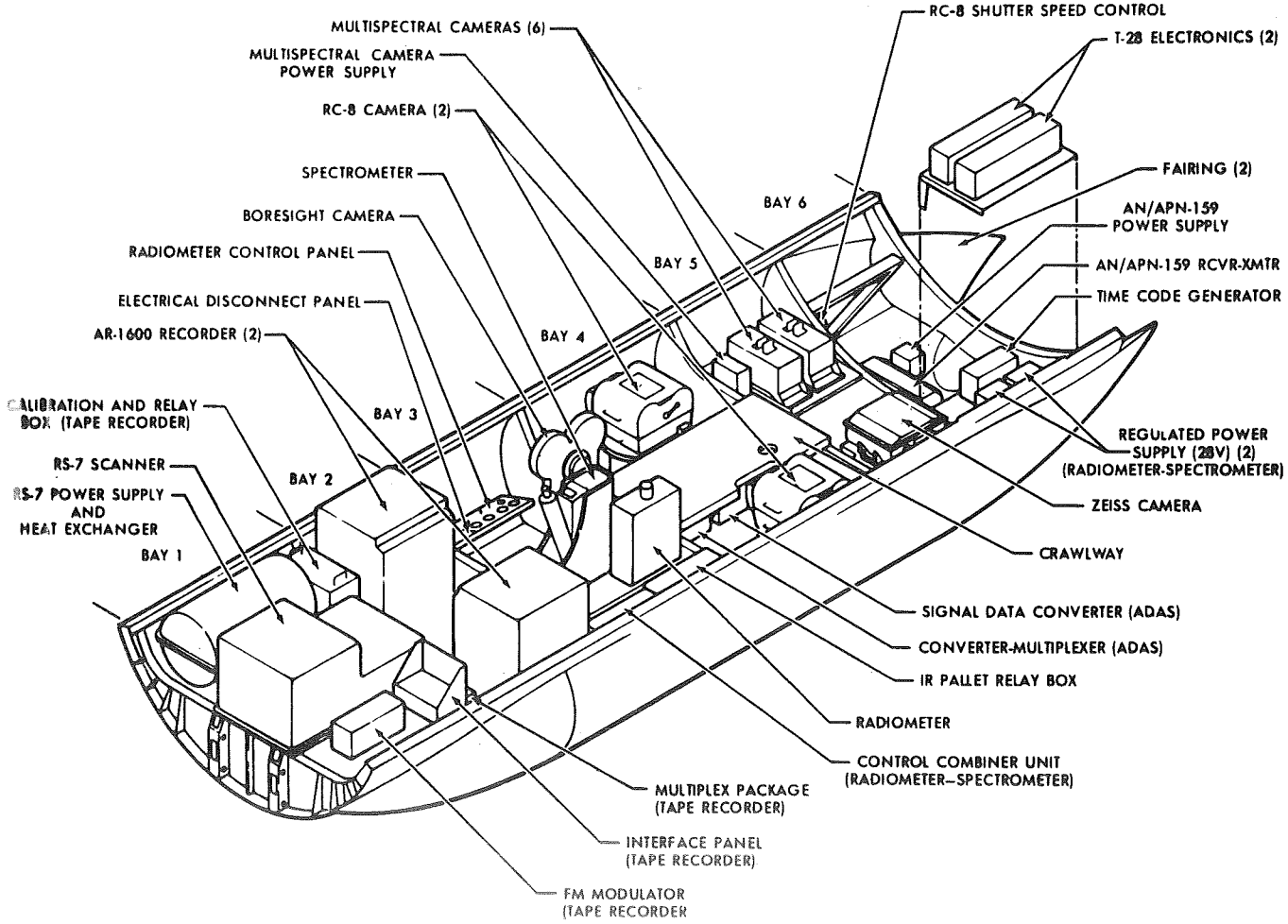
Cameras and other remote sensors carried by the RB-57F are housed in a pressurized instrument pallet in the belly of the aircraft. The pallet is divided into six compartments or bays. Electrically actuated doors are installed in bay 1 for the infrared scanner and in bay 3 for the infrared pallet system. Optical glass windows, mounted on hinged frames that open outward, are provided in bays 3, 4 and 5 to accommodate photographic equipment. Access doors in bays 2 and 5 permit servicing and removal of film magazines and tape recorder reels without having to remove the instrument pallet. Bay 6 contains communications and control equipment.

Data on reflected and emitted energy from Earth's surface and near sub-surface is collected and stored either as imagery on film or as electromagnetic information on recording tape. Two metric mapping cameras are mounted on gyroscope-stabilized platforms in bay 4.

RC-8 Camera System

The RC-8 metric, general mapping camera employs a 6-inch focal length, Universal Aviogon lens capable of recording color, color infrared, or conventional black-and-white data on a 9x9-inch film format with either monoscopic or stereoscopic coverage. The cameras provide high resolution terrain photography used in correlating and indexing data. They have a field of view of 74 degrees by 74 degrees and a magazine that will accept 200 feet (235 exposures) of unperforated acetate-base film, or 250 feet (295 exposures) of unperforated polyester-base film.

The camera system's gyro-stabilized platform maintains the optical axis of the camera fixed with respect to vertical; it increased image resolution by reducing the effects of aircraft vibration and roll and pitch motions. The platform also provides remote positioning of the camera azimuth to correct for "crabbing" of the aircraft.



RB-57F Instrument Pallet Layout

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Multispectral Camera System

A multispectral camera system consisting of six Hasselblad 500 EL cameras is located in the right side of bay 5. The six cameras, on fixed mounts, are arranged in two banks of three cameras each. The two banks of cameras may be operated independently of one another; but the three cameras within each bank must be operated simultaneously. The Hasselblad 500 EL camera is an electrically-driven, 70mm camera which exposes an image area of about 2 1/4 x 2 1/4 inches. The film magazine holds 23 feet of film, yielding about 100 exposures. Lens focal lengths of 40, 50, 80, 120, 150, 250, or 500mm may be used. However, all cameras in each bank must be equipped with the same focal length lens.

RS-7 Infrared Scanner

A Texas Instruments single-channel thermal infrared scanner is located in bay 1 of the instruments pallet. The scanner converts thermal infrared electromagnetic energy to visible light which can produce an image on film of the terrain directly below the aircraft. The sensor head in the scanning unit views a 100-degree field which is at right angles to the ground track. It scans this field 200 to 400 times per second, painting a thermal image line-by-line on a moving 70mm film. The film moves at a speed proportional to the speed and altitude of the aircraft, and the picture is corrected for aircraft roll by a roll servomechanism.

Infrared Pallet System

Unlike imaging sensors, the instruments of the infrared pallet system provide data which cannot be recorded as a "picture" without further signal processing. These so-called "non-imaging" sensors are mounted on a sub-pallet in bay 3 of the aircraft instrument pallet. The infrared pallet system consists of a spectrometer, a radiometer, and a boresight camera, all of which are boresighted along the same optical axis. The spectrometer output is an analog voltage representing irradiance which enters the detector aperture where it is compared to an internal reference.

The Block Associates Infrared Radiometer is boresighted with the spectrometer and the 35mm camera, giving the three instruments an overlapping field of view for mutual reference and data correlation. The radiometer produces an output voltage that varies with input energy.

The 35mm boresight camera is equipped with a screw-mount lens adapter and film magazines with 500-foot or 1200-foot capacities. Exposures are triggered at three frames per second by a flywheel on the radiometer.

CORN BLIGHT WATCH EXPERIMENT MANAGEMENT

Overall program direction for the experiment is provided by USDA. Dr. John M. Barnes, previously designated as Director of the National Federal-State Information Center for Corn Blight is Coordinator for USDA Activities. Dr. R. B. MacDonald, Technical Director, LARS/Purdue, and Chairman of the Corn Blight Watch Executive Committee is overall Program Coordinator. Dr. John DeNoyer, Director, Earth Observations Programs, NASA, is project manager for NASA. The Corn Blight Watch Executive Committee represents each of the participating organizations and maintains a continuing overview of the experiment. Members of the working group are:

Organization	Member
Agricultural Research Service (ARS)	Dr. Robert Miller
Economic Research Service (ERS)	Jerry Sharples
Extension Service (ES)	Dr. Buel F. Lanpher
Cooperative State Research Service (CSRS)	Dr. John M. Barnes
Statistical Reporting Service (SRS)	Richard Allen
Agricultural Stabilization and Conservation Service (ASCS)	Joseph Clifton Harold Jamison
National Aeronautics and Space Administration (NASA)	
Headquarters (HDQ)	Dr. Arch Park
Manned Spacecraft Center (MSC)	Allen H. Watkins
Ames Research Center (ARC)	Martin A. Knutson
Institute of Science and Technology (IST) University of Michigan	Phillip Hassell

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Organization	Member
Laboratory for Applications of Remote Sensing (LARS), Purdue University	Dr. R. B. MacDonald Dr. Marvin Bauer
Cooperative Extension Service (CES)	Howard Diesslin
Agricultural Experiment Station (AES)	Dr. Herbert Kramer

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